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Theorizing Sex Differences in Political Knowledge: Insights from a Twin Study

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Abstract

There is no theory that currently explains the gender gap in the psychological orientation to politics. This paper is an attempt to build theory and we make use of an empirical test to illustrate a pattern in the gender gap in political knowledge literature. We test for the source of variance in political knowledge between men and women using an ACE twin design. We find that the amount of the variance in political knowledge explained by the environment is the same for men and women, but there is a difference in the amount of variance explained by additive genetic effects. In fact, the additional variance in political knowledge among women is almost entirely driven by additive genetic effects. We discuss the implications of this finding in light of the literature on the "gender gap" in political knowledge and our own theoretical framework. We recommend implementing different measures of political knowledge as well as more nuanced theorizing to guide gender and politics research.

Key Words: sex differences; gender gap; political knowledge; twin study

Introduction

It is well established that women and men differ in their psychological orientation to politics (Burns, Schlozman and Verba 2001; Dolan 2011; Fox and Lawless 2004; Thomas 2012). In addition to willingness to run for office, expressing interest in politics, and political efficacy, men and women tend to differ in reporting their factual knowledge of

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politics, but how do we explain the gap? This question is not merely important from a measurement standpoint (e.g., Mondak and Anderson 2004), but has implications for our understanding of gendered political attitudes and behaviors. The gap can be reduced when controlling for a number of factors, but there remains a residual when measuring knowledge with the scale most widely used. This paper aims at providing insight on how we think not only about measuring something like "political knowledge" but also how we theorize gendered political behavior. We present a behavioral genetic analysis of sex differences in political knowledge using a genetically informative twin design[1] to parse out the source of variation in knowledge. We do so predicated on a framework for thinking about gendered patterns in political behavior as well as findings from the existing literature on gender differences in the psychological orientation to politics. We believe our findings give us insight on what is wrong with current, and seemingly gender neutral, measures of political knowledge.

[1] Behavior genetic approaches have been increasingly used in political science (e.g., Alford, Funk and Hibbing 2005; Hatemi et al. 2011; Hatemi and McDermott 2012) and have been informative in understanding attitudinal differences between men and women (e.g., Hatemi, Medland and Eaves 2009; McDermott and Hatemi 2011) because they explain the sources of variance instead of merely comparing mean differences. Additionally, political knowledge, political efficacy and political interest have been found to be highly heritable. But such studies did not explore potential differences between men and women (Arceneaux, Johnson and Maes 2012; Littvay, Weith and Dawes 2012).

A Socio-Relational Framework

The study of political attitudes and behaviors in our discipline has historically tended to assume similarities between the sexes, even while relevant differences were being (re)discovered throughout the social sciences. In 1982 Gilligan argued "theories formerly considered to be sexually neutral in their scientific objectivity are found instead to reflect a consistent observational and evaluative bias" (6). Even prior to that, Chodorow (1978, 167) suggested that girls' psychological development resulted in their unique experiences of individuation and relationship, but were not derivative of or inferior to that of boys – a notion that countered the male-centric theories dominating psychoanalysis at the time. Different does not mean inferior, according to Chodorow and others, and it seems relevant to echo such sentiments today. The assumptions we make about political behaviors, and the way we go about measuring them may reflect the "consistent observational and evaluative bias" Gillian suggested. We contend the residual gender gap in political knowledge is an artifact of a measurement that is not gender neutral. The empirical test we present later in this paper is one way to illustrate our contention.

In political science the measurement of attitudes and behaviors have proceeded without much reference to research outside the discipline that has identified potentially relevant sex differences. Certain attitudes and behaviors that have been theorized as epitomizing democratic citizenship are expected of both sexes, but should they be? As an example, in 1944 Lazarsfeld, Berelson, and Gaudet stated that, "[s]ex is the only personal characteristic which affects non-voting, even if interest is held constant. Men are better citizens but women are more reasoned: if they are not interested, they do not vote … [a] man, however, is under more social pressure and will therefore go to the polls even if he is

not 'interested' in the events of the campaign" (48-49). We think Lazarsfeld and colleagues were partially correct in their explanation that men and women perceive and engage politics differently, however, the pressure on men to go to the polls is not the only issue. That we expect interest or knowledge to translate into reasoned action[2] seems gender neutral, but what do we accept as political knowledge (and appropriate civic action, for that matter)?

Fowler and Schreiber (2008) refer to our human capacity for thinking about politics as "playground cognition." They note that "[o]n the playground, we are figuring out whom to cooperate with and whom to avoid; we are cognizant of social hierarchy and we engage in coalitional cognition, knowing that alliance with one group will entail exclusion from another. Even at rest on the playground we are constantly monitoring our social environment and our place in it" (913). Going beyond our disciplinary boundaries, as Fowler and Schreiber do referencing genetics and neurobiology, may help guide our thinking about politics. Sapiro (2003) cites that "[r]elatively little research explores the impact of physiological variation associated with sex on politically relevant phenomena …

[2] The notion that we expect political knowledge to translate into reasoned action (and better citizens) is cited by the following: Bartels 1996; Dahl 1989; Delli Carpini and Keeter 1996; Downs 1957, 79-80; Moore 1987; Page and Shapiro 1992; Powell 2000; Somin 2006; Sturgis 2003. The linking of "knowledge" - as measured by correct responses to a survey and to subsequent behavior such as voting for a candidate consistent with one's values – has proven to be an erroneous assumption about how people make decisions in a wide swath of the literature linking attitudes and behavior (Druckman 2012; Jost et al. 2003; Lupia, McCubbins and Popkin 2000 Zaller and Feldman 1992).

most political psychology research involving gender focuses on socio-cultural forces" (604). Motivation to attend to politics, for example, should no longer be explained merely from the perspective of socio-cultural gender role expectations, like the pressure men of Lazarsfeld's time felt that drove them to go to the polls more than women, but also involve consideration of patterns of emotionality in affiliative and avoidant behaviors, for example as consistent with "playground cognition."

The most basic expression of emotionality is the motivation to respond to socially relevant stimuli. Social contexts elicit affiliative and avoidant responses, very fundamentally, and people will approach when reciprocal capacity is signaled and avoid when it is not. Scholars argue there is form and functionality associated with gendered patterns of approach and avoidance and women have greater sensitivity to social and emotional cues of capacity and trustworthiness and tend to signal trustworthiness (e.g., kindness, sympathy, integrity) more than men who tend to signal capacity (Geary 2009; Vigil 2009). These general patterns are argued to be a result of a long human history of men and women using different strategies to get what they need to survive in complex and changing social contexts. Further evidence of this is the unique perceptual, neuroendocrine, and expressive biases that underpin approach and avoidance behaviors. These underpinnings differ between men and women in various socio-relational contexts including politics (Geary 2009).

Research suggests women's greater prosociality is the result of a long human history of male-biased philopatry, where women dispersed to live with non-kin. Where women have had to be (or are still today) reliant on non-kin or distantly related kin, more socio-relational maintenance behaviors for ensuring reciprocity would have been (or are)

necessary (Geary 2009; Hrdy 2009; Low 2000). Studies from social psychology illustrate women's preference for particular social arrangements that facilitate reciprocal trust cues – women tend to form and maintain smaller networks or groups than men. Experiments from both psychology, experimental economics, and political science show that women are more interpersonally oriented, avoiding overt hierarchies, and men are more group oriented and gravitate to hierarchies (Baumeister and Sommer 1997; Eckel and Grossman 1998; Gariel and Gardner 1999). Further, men tend to engage in competitive between-group interactions more than women (Niederle and Vesterlund 2007; Pemberton, Insko and Schopler 1996; Van Vugt, De Cremer, and Janssen 2007). These social psychological capacities are not distinct from politics, but rather underpin men and women's orientation to politics.

Those socio-relational differences between men and women underpin many complex social behaviors. For example, men's achievement goals are predicated on mastery of a task and separating themselves from others and further directed at the use of status and power. Even if in subtle ways, if competition and status are cued, men will respond in ways distinct from women. Women's goals, alternatively, are predicated on affiliative outcomes or setting themselves in harmony with others (Gaeddert 1985; Geary 2009). Stress responses in anticipation of events further reinforce these findings. Men produce greater stress response to events that display capacity (e.g., public demonstration of intelligence) whereas women's stress systems are more sensitive to social exclusion (Stroud et al., 2002). These findings articulate general patterns and, as with any trait or characteristic, we should expect to see variation both between and within the sexes though most of our studies stop at examining mean differences between men and women.

The framework that we propose to guide research on gender and political behavior involves the dynamic interaction of individual physiology, psychology, and socio-relational processes that give rise to specific political behaviors consistent with "playground cognition." Smith et al. (2011) presented a theoretical framework for thinking about the influence that genes have on political attitudes. They demonstrated that the influence is quite indirect, and the levels of analysis between genes and behavior include relevant biological systems, neurological bases of information processing and cognition, personality and values, and ideology (Smith et al 2011).[3] In short, genes "regulate the neurological processes that drive political and social behavior" (Fowler and Schreiber 2008, 914). This perspective suggests influences on individual behavior arise from *both* external social influences and internal psychophysiological processes. We would add that external socio-relational contexts may influence men and women differently. Further, internal psychophysiological processes may operate differently in men and women in response to such social contexts. Their model may have been put forth as gender neutral, but if we want to proceed as a predictive social science (as opposed to one that is merely descriptive) sex differences must be considered and modeled accordingly. The framework we propose to guide our thinking about modeling sex differences adapts elements from Smith et al (2011) and is presented in Figure 1.

[Figure 1 about here]

[3] The authors also note that even this model is overly simplified, but illustrates the multiple levels of modeling that would need to be undertaken in order to truly understand the impact of genes on complex political behaviors.

To briefly explain how Figure 1 may be useful in guiding research on political behavior with an eye to sex differences, consider that the realm of understanding sex differences in political science research is within the last two boxes on the far right of the diagram: Political Ideology and Specific Political Attitudes. We understand them as deriving from the Environment, but typically neglect influence from the boxes to the left of the diagram (as Sapiro reminds us in the quote cited above). The puzzle of the knowledge gap, which we discuss in the next section, is a case in point. Much of the gap has been empirically reduced by taking account of changes in environmental variables (e.g., level of education), but what of the residual gap? Perhaps moving to the categories on the left side of the diagram can provide insight.

In the next section we review the empirical findings to date regarding a "gender gap" in political knowledge. We then present an empirical test utilizing a twin study as a way to examine the potential source of the variation in political knowledge between men and women that may provide insight into what we are and are not accounting for in current measures. We conclude with a discussion of our findings in light of our theoretical framework.

Whither the Gender Gap in Political Knowledge?

Dolan (2011) cites, "That women exhibit lower levels of political knowledge[4] than men is a common and consistent finding in political science research" (97), but a series of

[4] Political knowledge has been defined as "factual knowledge about institutions and process of the government, current economic issues and social conditions, the major issues of the day, and stands of political leaders on those issues" (Delli Carpini and Keeter 1996, 1).

studies have identified measurement nuances and intervening variables that greatly decrease (and even reverse) the gap. We argue here that the theories put forth to date explains the reduction in the gap, but the source of the gap that remains is yet to be understood.

The notion that men are more knowledgeable has been brought into question by their greater propensity to guess in response to survey questions as opposed to selecting a "don't know" response (Mondak and Anderson 2004).[5] Lizotte and Sidman (2009) found that in 11 of the 12 surveys they administered, women were 1.5 times more likely to choose the "don't know" response. The authors find that models accounting for the inclination to say they "don't know" produce knowledge estimates for women that are much closer to, and sometimes exceed, the estimates for men. Further, stereotype threat produces relatively lower levels of reported political knowledge for women as contrasted with men when such threats are absent. For example, when the survey was presented as nondiagnostic, and when the interviewer was female, female respondents achieved higher accuracy (McGlone, Aronson, and Kobrynowicz 2006). Such findings are consistent with what we might expect given the response to complex socio-relational contexts. When competition is cued, men perform better and women's performance decreases.

[5] The Mondak and Anderson (2004) article illustrated that the knowledge gap was largely a feature of how political knowledge is measured in survey instruments. In short, they found that men are more likely to guess on political knowledge questions. Guessing leads to the appearance of greater knowledge, thus, creating the empirical "gap." By randomly assigning "don't know" responses, the gender disparity decreased by about 50%. The authors, however, were not able to ascertain the source of the remainder of the gender gap.

The *ability* to retain learned information, *opportunity* or access to the information in the first place, and *motivation* or interest in politics (Delli Carpini and Keeter 1996; Luskin 1990; Popescu and Toka 2009) have all been cited as important pieces of the constellation that is political knowledge,[6] and have been assessed individually for their specific role in explaining the gap. *Ability* has been operationalized as level of education or type of education (i.e., civics). In most of the studies that take education into consideration the gender gap is largely reduced (Burns, Schlozman, and Verba 2001; see also Lay 2011 for an example of knowledge favoring women and girls). Closely related to ability is *opportunity,* which refers to the availability of information in a certain context (Delli Carpini and Keeter 1996; Luskin 1990; Popescu and Toka 2009). Where women have greater access to political information they tend to do as well as men in response to knowledge questions (Burns, Schlozman, and Verba 2001). In other words, the gap is reduced when education and opportunity are controlled for.

Motivation seems to be the critical area in examining the gender gap in political knowledge. Verba, Burns and Lehman Schlozman (1997) demonstrate that women are less politically interested than men, echoing Lazarsfeld and colleagues (1944). They refer to this as the "engagement gap," and argue that such gender differences seem to be specific to

[6] Other factors, such as age, living in a city as opposed to living in a rural area, strength and direction of partisan attachment, and frequency of political discussion are also linked to the ability-motivation-opportunity triad and have been shown to have an impact on the level of political knowledge (Baum and Jamison 2006; Delli Carpini and Keeter 1996, 179; Luskin 1990; Popa 2013; Popescu and Toka 2009; Zukin and Snyder 1986).

politics and not a result of general personal attributes.[7] However, Karp and Banducci (2008) find that the presence of women as candidates and office holders can stimulate political engagement among women (see also Campbell and Wolbrecht 2006).

Dow (2009) finds that similarly situated men and women (i.e., controlling for SES [ability], working outside the home [opportunity], etc.) may invest the same in obtaining political knowledge, but men get a different return on investment than women. Using ANES data Dow finds that at least two-thirds of the gap in political knowledge results from differences in returns on investment in obtaining political knowledge. This also squares with why men are more inclined to guess. They get a different socio-relational "reward" (so to speak) than women would by doing so. We argue that if the "knowledge" men and women invested in was cuing something that motivated women the way the current knowledge questions appear to motivate men, this same conclusion could be drawn but instead favoring women.

As it turns out, this is precisely what happens. When the knowledge questions concern government services and programs (Stolle and Gidengil 2010; Thomas, Harell and Gosselin 2013) or on women's representation in national government (Dolan 2011), the gender gap in political knowledge is substantially reduced to the point that women and men have similar levels of knowledge or the gap favors women. In short, the traditional way of measuring knowledge is tapping something that motivates men (both to attend to the information in the first place, but also to guess) but not as much for women. According

[7] This observation appears to be empirically true for women running for office as well (see Fox and Lawless 2004), and instead of the "engagement gap" has been referred to as the "ambition gap."

to our framework we would argue that the socio-relational *benefit* to knowing about how many votes it takes to overturn a Presidential veto, is different for men and women. As long as such questions are the measure of knowledge that counts as "knowing about politics," women as a group are likely to elicit less knowledge than men as a group in addition to less efficacy.

These above-cited studies appear to converge on a common theme. The gap in political knowledge can be greatly reduced by accounting for ability and opportunity, which is addressed by theorizing about the changing role of women in society, but also by measurement manipulations such as encouraging non-guessing, and the absence of stereotype threat. We believe our socio-relational framework assists in explaining why each of these manipulations reduce the gap. What seems to be underpinning the residual gap is something particular to the particular questions asked (as illustrated by the Stolle and Gidengil and Thomas et al. studies). Are the seemingly gender-neutral questions that measure political knowledge actually biased? We believe the findings of our empirical test suggest as much.

In the next section we present an empirical test for the sources of variation in response to the traditional battery of political knowledge questions via a twin study, consistent with our socio-relational framework for thinking about sex differences (recall Figure 1). Twin studies have been employed by behavioral geneticists since the 1970s to explore the sources of variation in social and political attitudes (Eaves and Eysenck 1974, Martin et al 1986). It has only been in the last decade that political scientists adopted this method (e.g., Alford, Funk and Hibbing 2005). Political reasoning (or thinking about politics), unlike subjects taught in the classroom such as mathematics or other matters

involving complex reasoning, is neurologically more similar to other forms of social reasoning. Again, "playground cognition" is a better way to conceptualize how most people think about politics and genes influence this reasoning. Fowler and Schreiber (2008) note that "[w]hen people … are asked for judgments of political issues" they utilize the same parts of the brain as when thinking about solving social situations; "such findings suggest that political thinking is akin to social cognition" (914). We take this a step further and argue that because what matters socially often differs for men and women, political thinking does as well.

A twin study provides one way to examine the gender gap in political knowledge by considering the sources of individual variation on a trait (such as responses to a battery of political knowledge questions) instead of merely focusing on mean differences between men and women. Since social forces largely diminish the "gap," or mean differences, our test of variance can look at what is driving the remaining discrepancies. If differences in variance is due to genetic influences, this provides a different path for thinking about the residual gap as opposed to the status quo where discrepancies are assumed to be derived from environmental or societal factors.

A twin study is possible because there are individuals who differ in their genetic similarity – monozygotic (MZ) twins who are genetically identical and dizygotic (DZ) twins who share roughly 50 percent of the genes transmitted from their parents – but who grow up in the same environment. Variation in complex traits (i.e., political knowledge) can be parsed out via variance components modeling, or, genetic and environmental influences (Medland and Hatemi 2009). Correlations can be made between the two types of twins on the trait of interest, in this case responses to the political knowledge questions. If MZ co-

twin correlations are much higher than those of DZ twin pairs, this suggests the presence of additive genetic influences.

Correlations do not suffice, however. Figure 2 depicts the basic path model for twin resemblance. The test that remains is to assess which combination of additive genetic influences (A), common environmental influences (C), and unique environmental influences (E) best fit the data. In other words, the combination of parameters (ACE, AE, CE, or E) must be determined to be the most parsimonious explanation for the patterns of MZ and DZ twin pair correlations (Hatemi et al. 2011, 12). We perform this analysis and report the results in the following section.

[Insert Figure 2 about here]

Data and Methods

The data comes from a study of social and political attitudes collected in 2008-2009 administered to a sample of twins selected from the Minnesota Twin Family Registry. The Minnesota Twin Family Registry is comprised of about 8,000 twin pairs born in the state of Minnesota between 1936 and 1955. The registry was compiled between approximately 1983 and 1990 (see Lykken et al. 1990; and Krueger and Johnson 2002 for additional information on the Minnesota Twin Family Registry).

The Minnesota twin study of social and political attitudes is the first twin study specifically devoted to the subject matter. The mode of data collection was a web survey that was fielded between July and December of 2008 with a supplementary collection effort using a self-administered paper and pencil questionnaire between July and October of 2009. Given the characteristics of the Minnesota Twin Family Registry the sample is restricted in its age coverage. All respondents were between the age of 53 and 61 at the

time of the interview. Only same sex twin pairs were selected in the sampling phase. N=1349 interviewed individuals yielded n=596 matched twin pairs (MZ Males=143 pairs, MZ Females=213 pairs, DZ Males=86 pairs, DZ Females=154 pairs).[8] The sample also included 157 twins whose co-twin data was missing. Item and unit-missing data still produced coverage over 80.8% in the covariance estimation for the structural equation model.

The dependent variable, political knowledge, is operationalized using the 5-question, multiple choice quiz (this operationalization is widely used in the research cited above and is the basis for claiming the existence of a gap) by adding up correct responses adding up to a 6 point knowledge scale. Incorrect, 'not sure' responses and missing responses on some the knowledge questions were marked as wrong and summed to produce the knowledge score.[9] For respondents who failed to fill out to any of the knowledge questions, overwhelmingly due to incomplete questionnaire with the knowledge questions near the end, we marked as missing. The questions can be found in the Appendix.

Analyses

All analyses to explore the data were conducted with Mplus[10] using each individual (not pair) as an observation and always correcting for the non-independence of twins from

[8] Throughout the paper Monozygotic or identical twins will be abbreviated as MZ and Dizygotic or fraternal twins as DZ.

[9] We consider that "Not Sure" reflect a degree of ignorance similar to the one reflected by incorrect answers (see Luskin and Bullock 2006; Sturgis, Allum and Smith 2008).

[10] Muthen and Muthen 2008.

each other through cluster sampling correction. The average respondent got 3.539 questions correct with a variance of 2.321. The age and sex corrected mean difference for MZ and DZ twins is -0.001 (p=0.993). Age and sex corrected variances are MZ=2.166, DZ=2.185 (where the p-value for the difference is p=0.906). Male and female variances of knowledge differ more substantially (male=1.607, female=2.513; male-female, p<0.001) suggesting that separate treatment of males and females is warranted when decomposing the variance into additive genetic, common, and unique environmental effects. The means are also significantly different; women get 0.765 fewer questions correct (p<0.001). Despite the highly restricted variance of age in the sample, a year increase in age will lead to a correct answer on 0.031 more questions (p<0.1). This coefficient needs to be interpreted with caution ensuring that no inferences made outside of the sample's age range of 53 and 61. Since age is still a significant predictor, age is corrected for in subsequent analyses.

To decompose the variance in political knowledge we use a structural equation ACE model. Due to space restrictions we offer only a brief summary of the model. For a more extensive discussion please see Medland and Hatemi (2009).[11] In the ACE model the variance of the dependent variable is decomposed into additive genetic (A), common environmental (C), and unique environmental (E) effects using a structural equation model that treats these components as latent variables. Given the use of a genetically informative twin sample, we know that additive genetic effects are perfectly correlated for MZ co-twins and, on average, 0.5 correlated for DZ co-twins. Common environment is perfectly

[11] We also recommend referring to the authoritative work by Neale and Maes (2004), *Methodology for Genetic Studies of Twins and Families.* http://www.vipbg.vcu.edu/~vipbg/mx/book2004a.pdf

correlated for both MZ and DZ co-twins while the unique environment is uncorrelated across the twin pairs. For a visual representation of this structural equation model, again, see Figure 2. This structural equation model is estimated using maximum likelihood. Alternative models are then compared.

The classic two-group model where MZ twins constitute one of the model groups and the DZ twins constitute the other can be extended into a four-group model that also separates the groups by sex. The classical two-group model assumes equal additive genetic, common, and unique environmental contribution to the variance for both males and females. It also assumes equality of variance in the dependent variable for males and females. The utilization of this more complex four-group model is necessary since both the means and variances for knowledge are different between sexes and therefore we expect that the effects of A, C, and E may also be different.

Just like with the two-group model, where certain parameters of the model can be fixed, and the fit of the more parsimonious model tested, the same is possible with the four-group model. In addition to fixing certain parameters to zero, proportions or absolute sums of the variance explained by the different sources can also be equated between sexes. The following section presents the fit of the full and reduced models.

Results

We start model fitting through comparing the four-group saturated model that does not decompose the variance to the ACE components that estimates different additive genetic, common, and unique environmental effects for males and females separately. (See Table 1 for model fitting.) The p-value for the difference in model fit is within a 4 decimal rounding error of 1 suggesting it is appropriate to use the ACE model. Since C is estimated

at 0, we move to an AE model that fixes the C component at 0. This also does not deteriorate the fit significantly ($p=0.84$). We then equate the unstandardized A and E variance components across the sexes individually and jointly. Equation of the E component leads to an insignificant decrease in fit ($p=0.0875$) while fixing the A or jointly fixing the A and E components equal to each other across the sexes deteriorates the fit significantly ($p<0.01$ and $p<0.001$ respectively).

[Insert Table 1 about here]

In essence, this means that the amount of the variance explained by the environment (E) is the same for men and women. But there is a difference in the variance explained by additive genetic effects (A). The difference in variance for men and women come from additive genetic sources and not environmental sources. It is also important to highlight that variance in political knowledge does not appear to be influenced by socialization sources (C).

Medland and Hatemi (2009) criticized model reduction for small samples specifically in the context of fixing a variance component to 0. Their arguments could easily apply to equating parameter estimates across the sexes. We agree with Medland and Hatemi's arguments because with small samples it is always more difficult to detect actual differences (between sexes or from a 0 estimate) and fixing parameters might only seem to work for good-fitting models because they lack the power to detect actual differences. In other words, fixing components of the ACE model to 0 because they are not significant is inappropriate when the sample size is small and the reason for the lack of significance is the lack of power and not because the effect is close to 0. The best way to overcome this is

to estimate an insignificant component regardless. It leads to less power and wider confidence intervals, but more trustworthy results especially with small samples.

In light of these potential concerns we present the complete results for every model that is less restricted than the final best fitting model identified during the model fitting process. Based on those results depicted in Table 2, it is clear that no matter which model we run, we are consistently yielding similar results (although confidence intervals do get narrower with the more restricted models). Every parameter that is significantly different from 0 in the most restricted ACE model is also significantly different from 0 in the least restricted model. The qualitative magnitudes of the parameter estimates also do not change substantially.

[Insert Table 2 about here]

While past studies within political science focus predominantly on the standardized proportion of variance attributed to additive genetic, common and unique environmental components, given the differences in total trait variance across the sexes the unstandardized components are more telling in our case.[12] For reference, Table 2 presents

[12] Standardized components add up to 1 (or 100%), whereas unstandardized components add up to the total variance. In behavior genetics the use of unstandardized component is very common as it is more informative (see for example Neale and Maes 2004, 166). The advantage of standardized results is that it is easier to understand hence its popularity in political science where twin studies are considered to be new still. But one of the limitations of using the standardized components is that the results are inaccurate when the variances are different between the groups studied (in our case men and women). In fact, when the variances are different between groups, as they are in our analysis, it makes

both standardized and unstandardized results. The amount of variance unique environmental effects are responsible for are practically the same for men and women. There is a sex difference, however, on the amount of variance additive genetic effects are responsible for. In fact, additive genetic effects seem to drive the difference in variance almost entirely.[13]

Beyond the difference in variation there is also a mean difference present between sexes. Based on the available information we can only speculate what contributes to the differences in the means but seeing that most of the people in the sample got all knowledge questions right serves as a guide. Since the unique environmental contributions between the sexes are the same, it suggests that the differences in the additive genetic components

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little sense to use the standardized results as it equates unequal variances in the process of standardization leading to misleading results.

[13] Sensitivity analysis showed that no single item drove this result. While item by item analysis was not possible (since dichotomous items do not have variance, hence having to equate men to women when using a probit link function, we did test what happens when we exclude one question from the scale, testing all combinations. Results did not show drastic variance, but this is no surprise as none of the questions are in line with what, for example, Stolle and Gidengil (2010) argue to use to minimize the gender differences in the means. Based on the evidence presented, we argue that their argument extends to the variance as well.

are forcing the mean political knowledge downward for females in presence of a ceiling effect produced by a low number of relatively easy questions asked.[14]

Limitations

One limitation of the ACE model is that it tests the impact of certain sources on the variance, not the mean. A reasonable question could arise: what is the source of the difference in means between men and women? Is the difference in means due to genetic differences? We cannot definitively answer this question with the data we have available to us in the Minnesota Twins Political Survey. To pursue an answer to this type of question we would need to explore the impact of potential sex chromosomes (Hatemi, Medland and Eaves 2009) or differential functioning of specific genotypes across men and women.

The analysis does come with limitations provided by the data and assumptions made by the model.[15] The Minnesota Twins Political Survey is one of the first sources to provide detailed political data collected on a twin sample. Unfortunately this sample is heavily restricted by age and geography and we have little information as to how these results would generalize to other age groups and people from different areas of the country. Also, the sample is relatively small. This is one of the reasons DZ co-twin

[14] In addition, we reanalyzed the data considering anyone who had a single "Not Sure" response to any of the knowledge questions as missing data. This only inflated the reported sex differences. The results we present hold under these circumstances and, in fact, become more pronounced when the difference between male and female heritabilities are concerned.

[15] The latter is discussed in detail in Medland and Hatemi (2009), but see also Littvay (2012) for why some of these are not of substantial concern.

correlation statistics might be insignificant, rendering the classical twin model unreliable. Further, males in the sample are underrepresented, though this is not uncommon for twin samples. Additionally, various survey behaviors, such as nonresponse or response biases, can also be heritable producing additional confounds to our study (Thompson et al 2011, Littvay et al 2013, Littvay 2010)

Finally, the presented twin models cannot rule out the possibility of an omitted variable bias. It does not take into account interaction effects both within and across the A, C and E components and the best fitting AE model assumes that C is 0. While we know that the AE model shows superior model fit statistics compared to the ACE model, with a much larger sample it is possible that a significant C component would be detected and a more nuanced picture could be drawn fine tuning the exact proportions of contribution to the total variance. The omission of gene by gene and gene by environment interactions can also bias the results, though Verhulst and Hatemi (2013) suggests this bias is negligible.[16]

Discussion

Our empirical findings suggest that the environment is not the sole source driving the differences, but rather the differences stem from variation driven by heritable factors when using a conventional scale for measuring political knowledge. We will address our findings in this section in two ways. First, we articulate what the findings of our analyses do and do not mean. In light of this, we argue that the concept and subsequent measurement of political knowledge itself contains a gender bias that is tapping something dispositional that is driving the difference (i.e., lesser variance for men as compared to women). Second, we discuss how our findings may further illuminate how researchers

[16] But see also Shultziner's essay on the topic (2013).

should think about and measure political knowledge (see Stolle and Gidengil 2010; Thomas, Harell and Gosselin 2013) and we hope to set the stage for more nuanced approaches to studying gender and political behavior.

The preceding analysis suggests that the variance explained by the environment is the same for men and women. There is, however, a difference in the amount of variance explained by additive genetic effects. This finding is potentially controversial but we want to caution readers not to interpret "amount of variance explained by additive genetic effects" as "caused by genes." Twin studies do not test for a direct genetic causal relationship (recall Figure 1). It is a tool to identify presence of heritability and, in this case, differences that may exist among men and women. We do this not to pronounce that men are "genetically inclined to X …" or "women are genetically inclined to Y …" but to illuminate the possibility that the way we have been thinking about and measuring political knowledge might be gender biased as our test illustrates that the current scale widely used for measuring political knowledge elicits more than mean differences. It elicits greater variance for women, and less variance for men.

Interpretation of our results suggests the variation among women is being driven by additive genetic effects as opposed to environmental sources, which is what the literature to date has pointed to as the causal mover of the knowledge gap (e.g., the more education and access women have, the better they perform on the knowledge questions). We again caution the reader not to misinterpret our findings. It may seem as though we are arguing that "men are knowledgeable and women either are or are not." That is too simplistic an interpretation based on our findings of differences in variance. To think about this in a more nuanced way, and in a way that we hope might inform future measurement of

political knowledge, we now turn to the notion of variance in political knowledge being *heritable*. What could that possibly mean?

A finding such as the one presented in this paper raises an important theoretical question: Why would the additive genetic component influence variation in women's political knowledge more than men's? To respond to this question we draw on recent studies that have considered heritability and a gender gap. When there is a difference in heritability between men and women on a trait with more variation in one sex but not the other, there may be adaptation involved – or, something in the psychological or behavioral trait that is relevant for survival and reproduction to one sex but not the other. Hatemi, Medland and Eaves (2009) cite that the genetic variation will be *less* for traits exposed to stronger selection. Evolutionary logic may very well predict *lower* variance on the heritable trait since things that matter most for survival and reproduction are most tightly regulated. So the key interpretation of this difference has less to do with a greater spread of political knowledge for women and more to do with this particular measure political knowledge tapping something that is particularly salient for men. Consistent with "playground cognition" our brains attend to those aspects of social and political life that are most likely to serve us well.

What the literature on the knowledge gap cited above converge upon is the notion that men and women are more or less likely to be motivated to attend to various kinds of political knowledge given the relative "return on investment." We suggest the "return on investment" can mean anything from the social-acceptability of reporting you "don't know" on a test of knowledge, being cued about competition and hierarchy, or the extent to which

spending time learning one type of political knowledge over another is likely to bring about practical social and material benefits.

Lizotte and Sidman (2009), McGlone, Aronson, and Kobrynowicz (2006), and Mondak and Anderson (2004) all illustrate differing forms of risk-taking or risk-averse behaviors and find changes in the knowledge gap accordingly. In addition to the "propensity to guess" research, perhaps the most important clues regarding political knowledge and the gender gap comes from Stolle and Gidengil (2010) who illustrate that "politics" is not merely the campaign horse races, the who's who of office holders, and other civics quiz type questions. Politics is also about goods and services, access, and identifying contexts when one's views are more likely to be represented.[17] Women are as, if not more, knowledgeable as men about these aspects of politics (see also Dolan 2011; Karp and Banducci 2008). Although women are nearly as likely to correctly respond to the knowledge questions when controlling for education, SES, and so forth, there remains a gap that is remedied by changing the nature of the questions. Unfortunately, our data does not allow us to run the analyses using those "practical" knowledge questions,[18] but we hope

[17] For another treatment of this idea, see Hannagan 2008a and Hannagan 2008b.

[18] Examples of "practical" political knowledge questions (from Thomas, Harell and Gosselin 2013) include: "If someone is working in Canada and has to take care of a seriously ill relative, how many weeks of compassionate care benefits are paid?" and "Imagine someone is trying to rent an apartment in Calgary. If they were refused an apartment and thought it was because they were a student, where would be the BEST place to go to make a complaint?" and "If someone had to go to court and could not afford a lawyer, where would be the BEST place to go?"

that providing our framework for thinking about why there may be differences and what types of questions may tap a gendered response will encourage others to further investigate this hypothesis.

Based on our socio-relational framework, men and women may attend to different types of information in varying social contexts and in response to the affiliative or capacity-driven consequences. Thinking about these differences may assist in better predicting attitudes and behaviors. And returning to Gilligan, Chodorow and Saprio, such findings need not result in men's focus of attention or resulting behaviors being more valid than women's. Measuring "political knowledge" could arguably be undertaken in a number of different ways. We may understand politics to be about the operation of government and how power is distributed, but also about the distribution of goods and services and even the relationship between citizens and government (e.g., Thomas, Harell and Gosselin 2013). We encourage the reader to think more broadly about the questions measuring political knowledge in their survey instruments. Political knowledge as presently measured in the traditional battery of questions is all about the contest, the hierarchy, and power. Politics so defined may be particularly salient for men because they get a greater socio-relational return on investment for knowing about these aspects of politics – thus the lesser variance finding from our test. Women are likely to have a greater psychological orientation to other aspects of politics, such services and policies impacting their communities and their families (Stolle and Gidengil 2010; Thomas, Harell and Gosselin 2013), as well as who they may look to best further their political interests.

We suggest our findings that the additive genetic effects impacting greater or lesser variation in women and men's responses to these questions tell a story. The story is that

these particular questions measure an aspect of politics that resonates with men's psychological orientation more than an aspect of politics that would resonate with women's. Change the "cueing" of that orientation and you change knowledge reports as well as related behavior. Due to the limits of our data, we cannot directly test this hypothesis, but we hope to see other scholars pick up where we have left off and engage this inquiry further.

Politics is about the ability to identify and negotiate for what you need within the spheres of political exchange in which you operate. There are good reasons for these spheres to be perceived somewhat differently by men and women, and for their strategies in attending to information to be different as well. Former Ambassador and Governor of Vermont Madeleine Kunin described her experience entering "politics" the following way:

> I was unknowingly preparing for a political life … None of the activities I engaged in met the definition of "political," but they taught me political skills. The difference between community activities and political action is simply one of scale … When I was eventually elected to public office, I discovered I was far better prepared than I had anticipated. I had underestimated the enormous amount that I had learned in the community and was unaware of my ability to transfer my knowledge to public life (as cited in Mayhead and Marshall 2005, 74).

She did not realize what she was doing was political or had any transference to "politics," because it did not match up with the prevailing conception of political behavior and politics. Her perception of what needed to be attended to and her motivation to make it happen *was* political behavior. When we begin asking women (and men) about their communities and things that immediately matter for their well-being, we will better understand the relationship between political knowledge and modes of citizenship that include many aspects of political behavior. As Mondak and Anderson (2004) state, "it

makes no sense to seek out a reliable scale that measures the wrong thing … reliability is desireable only as a means toward validity, not as a substitute for validity" (507).

Widespread assumptions about male and female political behavior are ripe for reconsideration and research pertaining to women's political behavioral repertoires requires a multi-disciplinary approach. We strongly advocate for further investigations pertaining to gender differences in political attitudes and behaviors that employ more nuanced theoretical frameworks to inform empirical analyses.

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Appendix: Multiple Choice Knowledge Questions with Offered Responses

1, Who has the final responsibility to decide if a law is constitutional or not?
(response options: The President, Congress, The Supreme Court, Not sure)

2, Whose responsibility is it to nominate judges to the Federal Courts?
(The President, Congress, The Supreme Court, Not sure)

3, Which of the political parties is more conservative than the other at the national level, Democrats or Republicans? (Democrats, Republicans, Not sure)

4, How much of a majority is required for the U.S. Senate and House to override a presidential veto? (response options: A bare majority of 50% plus one, Two-thirds majority [67% more more], Three-fourths majority [75% or more], Not sure)

5, What is the main duty of the U.S. Congress? (response options: To write laws, To administer the President's policies, To supervise States' governments, Not sure).

	Female				Male			
	% of correct	% of incorrect	% of DK	N	% of correct	% of incorrect	% of DK	N
Who has the final responsibility to decide if a law is constitutional or not?	62.51	29.52	7.40	827	82.16	13.24	3.01	494
Whose responsibility is it to nominate judges to the Federal Courts?	63.19	18.13	13.05	826	78.95	12.97	8.07	494
Which of the political parties is more conservative than the other at the national level, Democrats or Republicans?	71.19	14.54	14.12	828	80.15	10.49	9.31	494
How much of a majority is required for the U.S. Senate and House to override a presidential veto?	69.19	12.67	18.09	828	83.35	6.47	10.18	493
What is the main duty of the U.S. Congress?	59.06	23.32	17.63	828	78.10	11.74	8.33	493

Figure 1: Socio-Relational Framework of Genetic, Biologically Relevant Systems, Information Processing Bias, Personality/Values, Ideology, and Specific Political Behaviors. (Adapted from Smith et al., 2011).

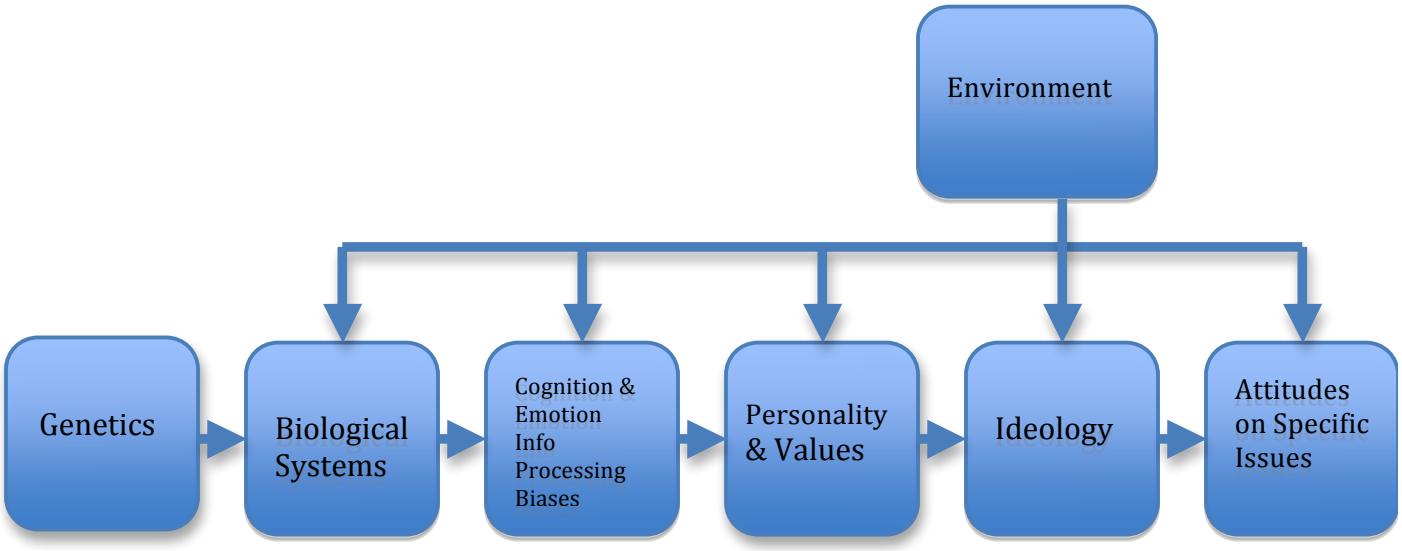
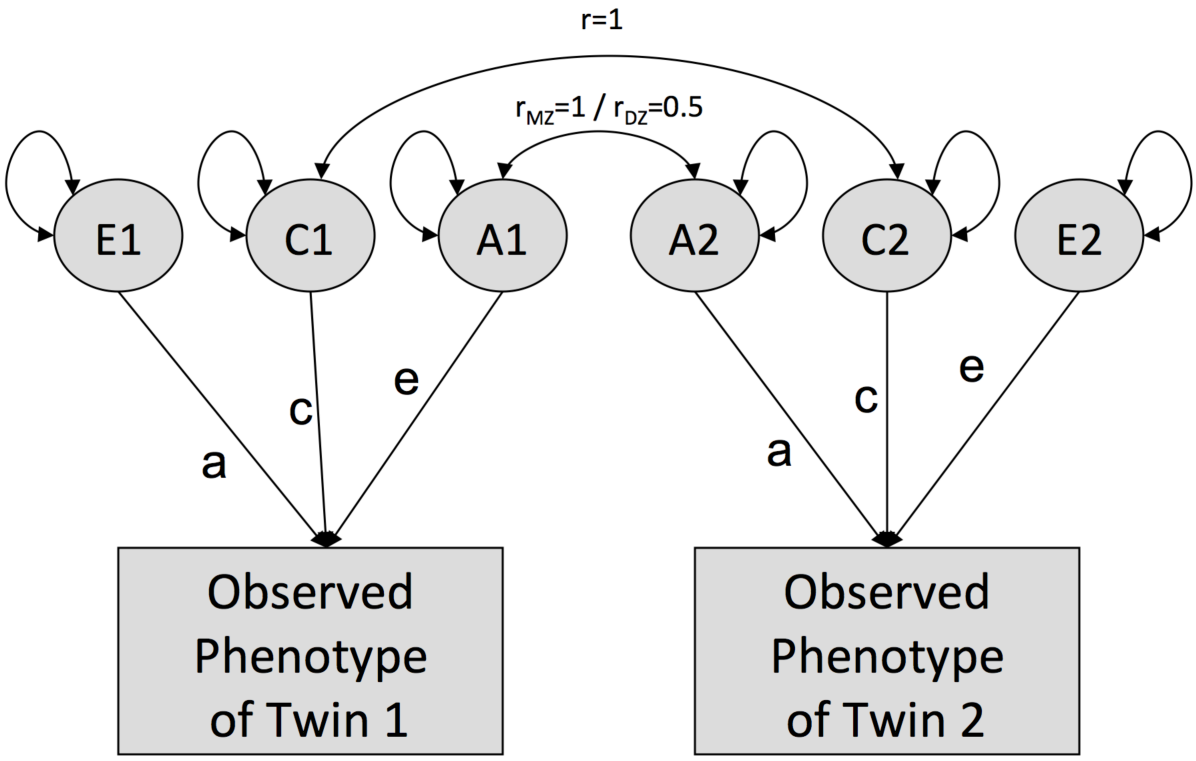


Figure 2: ACE Twin Design



A – [A]dditive Genetic Effect, C – [C]ommon Environmental Effect, E – Unique [E]nvironmental Effect for Twin [1] and Twin [2].

Table 1: Saturated and ACE model fit statistics.

Comparison to the ACE model	-2LL	df	p-value
4 Group ACE Model	8993.792		
4 Group AE Model C=0	8994.142	2	0.8395
AE M=F for A	9004.226	3	0.0152
AE M=F for E	**8997.062**	**3**	**0.3518**
AE M=F for A and E	9018.944	4	0.0000

Comparison to the AE model	-2LL	df	p-value
4 Group AE Model	8994.142		
AE M=F for A	9004.226	1	0.0015
AE M=F for E	**8997.062**	**1**	**0.0875**
AE M=F for A and E	9018.944	2	0.0000

Best fitted model Bolded; Chi-square difference in fit between the saturated model and 4 group ACE model is insignificant at p>0.9999.

Table 2: Twin variances, co-twin covariances, correlations and A, C and E variance decomposition with 95% confidence intervals*Twin variances*

	vMZ Male	vMZ Female	Age Effect	rMZ Male	rDZ Male	rMZ Female	rDZ Female	A Male	C Male	E Male	A Female	C Female	E Female
Saturated Model	1.612	2.509	0.032+	0.805***	0.162	1.397***	0.813***						
Unrestricted ACE	1.612	2.509	0.032+	0.767***	0.384***	1.398***	0.813***	0.767 (0..45-1.12)	0 (0-0.69)	0.85 (0.62-1.13)	1.17 (0.23-1.68)	0.228 (0-1.03)	1.111 (0.88-1.39)
AE Model C=0	1.617	2.503	0.03	0.767***	0.384***	1.409***	0.704***	0.767 (0.49-1.09)	-	0.85 (0.63-1.13)	1.409 (1.10-1.70)	-	1.095 (0.87-1.35)
AE M=F for E	1.656	2.48	0.03	0.658***	0.329***	1.482***	0.741***	0.658 (0.39-0.92)	-	0.999 (0.83-1.19)	1.482 (1.22-1.75)	-	0.999 (0.83-1.19)

Unstandardized age effect, co-twin covariances and unstandardized A, C and E variance decomposition with 95% confidence intervals in parenthesis

'+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

	Std Var Male	Std Var Female		rMZ Male	rDZ Male	rMZ Female	rDZ Female	A Male	C Male	E Male	A Female	C Female	E Female
Saturated Model	1	1		0.499***	0.1	0.558***	0.325***						
Unrestricted ACE	1	1		0.474***	0.237***	0.558***	0.325***	0.474 (0.29-0.63)	0 (0-0.43)	0.526 (0.38-0.68)	0.466 (0.09-0.64)	0.091 (0-0.42)	0.443 (0.35-0.56)
AE Model C=0	1	1		0.474***	0.237***	0.564***	0.282***	0.474 (0.32-0.62)	-	0.526 (0.38-0.68)	0.563 (0.46-0.65)	-	0.437 (0.35-0.55)
AE M=F for E	1	1		0.397***	0.199***	0.598***	0.300***	0.397 (0.27-0.52)	-	0.603 (0.48-0.73)	0.597 (0.51-0.67)	-	0.403 (0.33-0.49)

Standardized age effect, co-twin correlations and standardized A, C and E variance decomposition with 95% confidence intervals in parenthesis

'+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001